

CHEMICAL ANALYSIS OF WATER SAMPLES COLLECTED DURING CROSS DRIFT BULKHEAD ENTRIES

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In ventilated drift sections, no continuous dripping (or seepage) has been observed in either the Exploratory Studies Facility (ESF) Loop or the Enhanced Characterization of Repository Block (ECRB) Cross Drift at Yucca Mountain. The lack of seepage may be explained by the capillary-barrier mechanism, with capillary forces holding water within the rock mass. Another explanation is related to ventilation that can remove a large amount of moisture, dry the rock behind the drift walls, and suppress seepage.

To determine whether seepage occurs when ventilation is minimized, the last one-third of the ECRB Cross Drift was sealed with multiple bulkheads. The first two bulkheads (at Station 17+63 and Station 25+03) were installed in the ECRB Cross Drift in June 1999. The influence of heat sources (associated with the Tunnel Boring Machine used in the ECRB Cross Drift excavation in 1997 and 1998) on drift conditions was recognized to be a problem, and a third bulkhead (at Station 25+99) was installed in July 2000. A new bulkhead (at Station 22+01) was installed in November 2001 to further improve the spatial resolution. Bulkheaded sections are located to isolate regions in the drift most likely to show seepage under ambient conditions, as predicted by the site- scale UZ flow model and drift-scale seepage model (CRWMS M&O 2000a; 2000b).

The moisture conditions within the nonventilated zone were observed during several periods when the bulkhead doors were temporarily opened. During the entries, the entire ECRB Cross Drift was accessible for visual inspection. Wet spots were observed, and water samples were manually collected from small pools of water. This report summarizes chemical concentrations of measured constituents from samples collected in the ECRB Cross Drift. In the latest entry (October 1–December 20, 2001, as currently planned), additional borehole sensors, wetting front sensors on the drift wall, seepage collection systems along the drift, gas sampling ports, and drift moisture sensors were installed.

Most of the initial samples were collected directly from pools that had formed on the conveyor belt, and these samples were of brownish to dark brown color, with some examples shown in Figure 1. Their chemical compositions show high and spurious concentrations of many constituents, as shown in Table 1. These samples are likely contaminated from the conveyor belt resulting from the belt usage/operation before ECRB Cross Drift closure, with the degree of contamination unknown and unable to be quantified. Contamination of the conveyor belt may include salt accumulated from water evaporation following transportation of the tuff debris, as well as other miscellaneous contamination. Therefore, these samples may not yield useful information about the origin of the water (condensate or seepage) observed in the ECRB Cross Drift behind bulkheads.

Subsequently, three samples were collected from collection containers placed on the top of the conveyor belt. These samples are clear (Figure 1). Their chemistry, particularly low chloride and silica contents, indicates that this water is condensate (Figure 2). The water does not have the chemical signature of the construction water that contains about 20 mg/L of lithium bromide added to J-13 well water. Condensate, and subsequent dripping down, could occur as a result of vapor-to-liquid transition associated with local temperature variations in a humid environment. The moisture conditions measured by humidity and temperature probes support the presence of drift moisture variations (BSC 2001). These clear samples also show a relatively high amount of calcium and a high sulfate/chloride ratio, suggesting some minor contamination from either rock grout or rock dust (Figure 2). Some grout or dust present along the drift crown above the sampling containers may have dissolved in the condensate prior to collection. Samples collected on the drift wall (using a needle syringe for SPC566308 in Table 1, and absorbent pad attached to the wall) show an even higher concentration of calcium and a larger sulfate/chloride ratio, resulting from the direct contact of the sample with the rock.

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References:

CRWMS M&O 2000a (U0050). UZ Flow Models and Submodels. MDL-NBS-HL-000006 Rev 00. Las Vegas, Nevada: CRWMS M&O.

CRWMS M&O 2000b (U0080). Seepage Calibration Model and Seepage Testing Data. MDL-NBS-HL-000004 Rev 00. Las Vegas, Nevada: CRWMS M&O. ACC MOL. 19990721.0521.

CRWMS M&O 2000c (U0085). Analysis of Geochemical Data for the Unsaturated Zone. ANL-NBS-HS-000017 Rev 00. Las Vegas, Nevada: CRWMS M&O.

BSC (Bechtel SAIC Company) 2001 (U0015). In-Situ Field Testing of Processes. ANL-NBS-HS-000017 Rev 01. Las Vegas, Nevada. (in review).

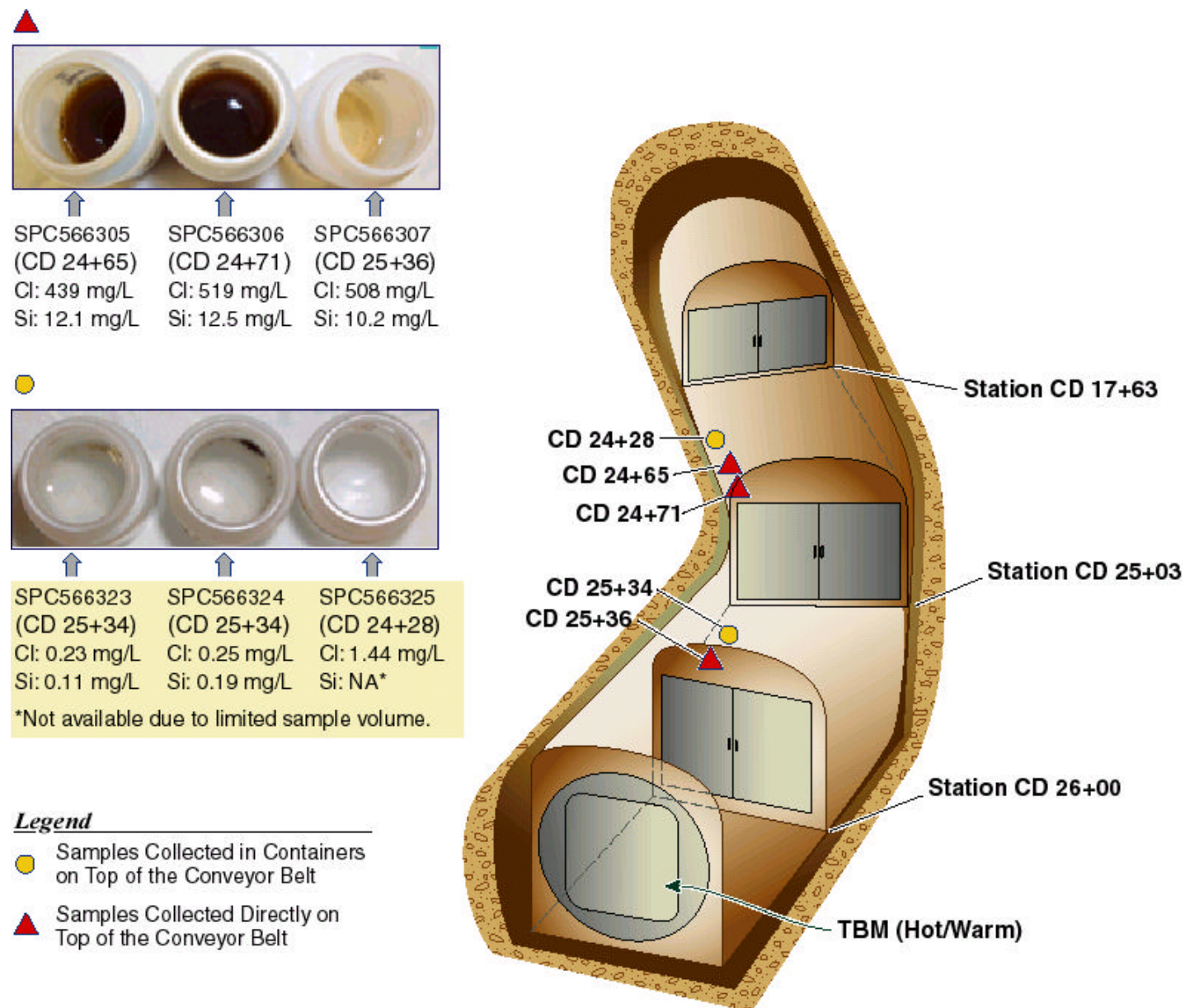


Figure 1. Chemical Analyses of Liquid Samples Collected During Bulkhead Entries.

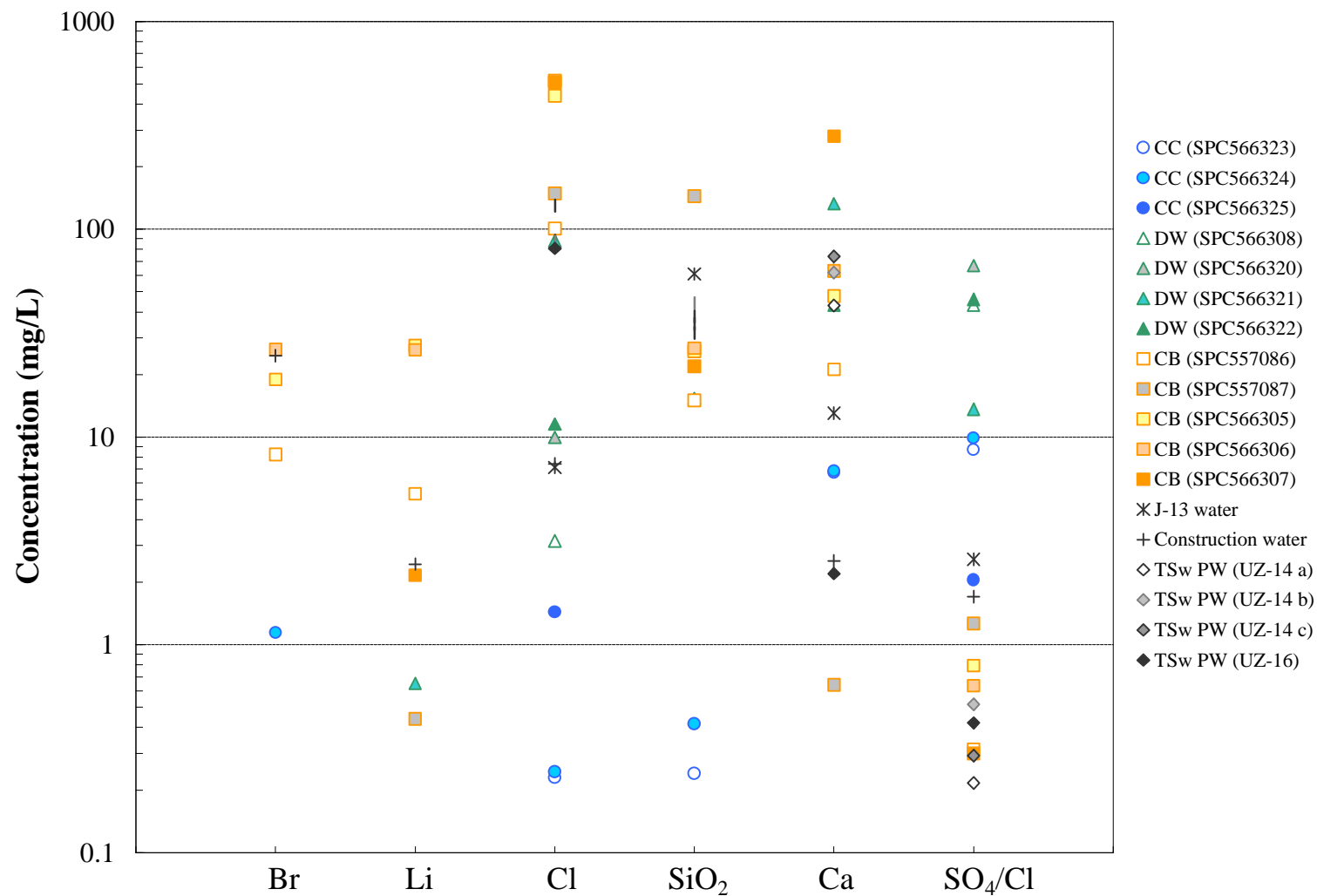


Figure 2. Comparison of chemical signatures. Unit of the Y-axis is in mg/L, except for the ratio of sulfate to chloride (dimensionless). Samples are grouped as follows: CC in collection container, DW on drift wall, and CB on conveyor belt. J-13 well water composition is from MOL.20001206.0114. Construction water data presented here are an average value from seven samples. TSw PW: pore water in Topopah Spring welded tuff unit; data from Table 6 of CRWMS M&O (2000c).

Table 1. Chemical Data for Liquid Samples Collected in the Cross Drift

Specimen ID#	Sample Location	Collection Date	Br ⁻	Cl ⁻	F ⁻	NO ₃ ⁻	SO ₄ ²⁻	Ca ²⁺ (mg/L)	Li ⁺	Mg ²⁺	K ⁺	Na ⁺	SiO ₂
SPC557086	Conveyor belt - Station CD 24+83	1/31/00	8.23	101	ND	ND	31.7	21.2	5.33	3.10	19.0	88.6	15.0
SPC557087	Conveyor belt - Station CD 25+17	1/31/00	ND	149	29	ND	188	0.64	0.44	0.10	160	139733	144
SPC566305	Conveyor belt - Station CD 24+65	5/03/00	18.9	439	ND	ND	349	47.6	27.5	9.00	27.9	195	25.9
SPC566306	Conveyor belt - Station CD 24+71	5/03/00	26.3	519	9.19	ND	330	62.9	26.3	12.0	35.3	230	26.7
SPC566307	Conveyor belt - Station CD 25+36	5/03/00	ND	508	6.41	24.1	152	280	2.16	34.0	36.3	191	21.8
SPC566308	Shotcrete- Station CD 25+50	5/03/00	ND	3.16	ND	4.29	136	---	---	---	---	---	---
SPC566320	Absorbent pad - Station CD 25+62	6/28/00	ND	9.95	7.05	3.99	665	63.5	ND	11.5	172	105	<1.0
SPC566321	Absorbent pad - Station CD 25+62	6/28/00	ND	88.0	15.8	5.79	1197	133	0.65	18.1	163	233	15.4
SPC566322	Absorbent pad - Station CD 25+62	6/28/00	ND	11.5	8.02	2.20	531	43.0	ND	6.50	141	78.6	<1.0
SPC566323	Collection container - Station CD 25+34	6/28/00	ND	0.23	ND	1.63	1.99	6.73	ND	0.40	0.84	1.56	0.24
SPC566324	Collection container - Station CD 25+34	6/28/00	1.14	0.25	ND	ND	2.42	6.87	ND	0.40	0.90	1.65	0.42
SPC566325	Collection container - Station CD 24+28	6/28/00	ND	1.44	ND	2.34	2.95	---	---	---	---	---	---

SPC573600	Conveyor belt - ~5 m from 2nd bulkhead	1/22/01	45.4	---	---	---	---	---	0.11	---	---	---	---
SPC573601	Conveyor belt - Station CD 25+10	1/23/01	72.5	---	---	---	---	---	14.8	---	---	---	---
SPC573602	Conveyor belt - Station CD 25+37	1/22/01	79.7	---	---	---	---	---	0.17	---	---	---	---
SPC573603	Conveyor belt - Station CD 25+21	1/23/01	52.5	---	---	---	---	---	0.13	---	---	---	---
SPC573604	Conveyor belt - ~7 m from 2nd bulkhead	1/22/01	56.3	---	---	---	---	---	12.31	---	---	---	---
SPC573605	Conveyor belt - Station CD 25+42	1/22/01	ND	---	---	---	---	---	0.22	---	---	---	---

Notes: Liquid samples were filtered through 0.45 µm filters prior to chemical analyses. Phosphate was not detected in any of the liquid samples.

ND: not detected, e.g., below the analytical detection limit (about 0.1 mg/L).

---: Data not available.